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THE VETERINARY JOURNAL

A MONTHLY REVIEW OF VETERINARY SCIENCE

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The Veterinary Journal

AUGUST, 1947

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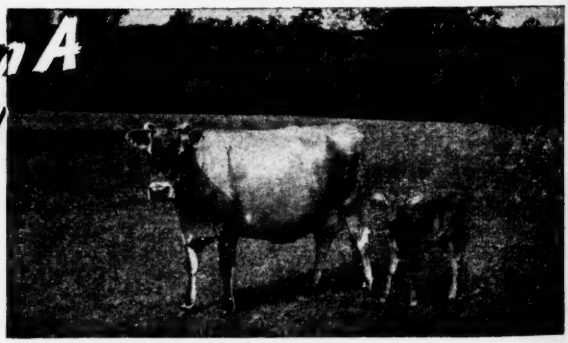

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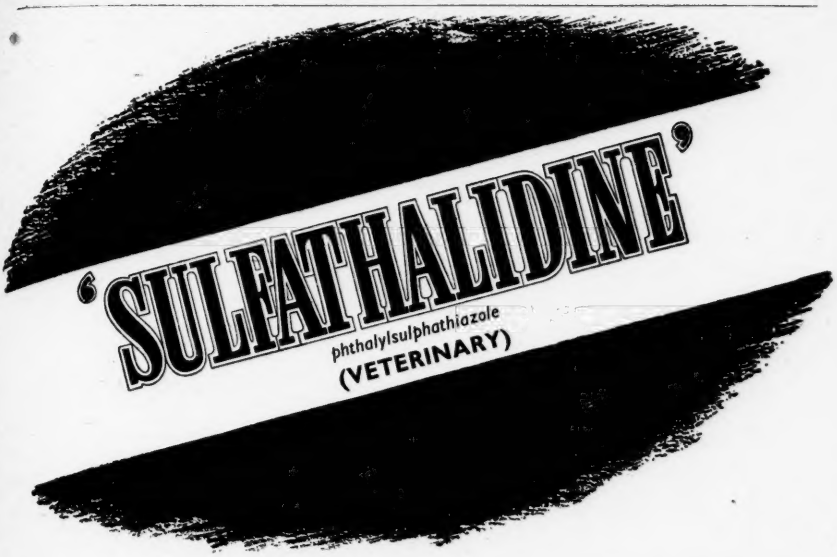

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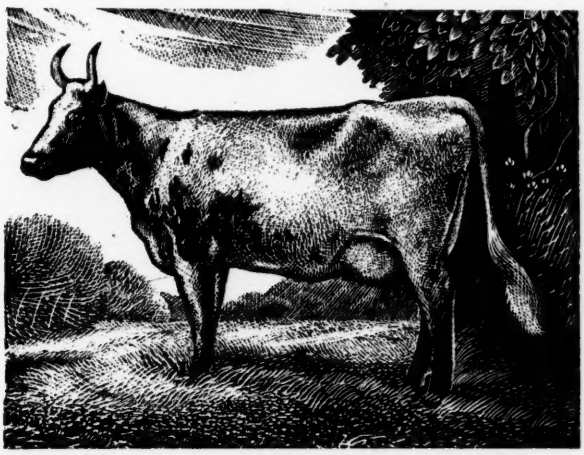

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THE VETERINARY JOURNAL

EDITORS: T. DALLING, *M.A., M.R.C.V.S.* J. McCUNN, *M.R.C.V.S., L.R.C.P.*

Vol. 103 August, 1947 No. 8

EDITORIAL

THE BRITISH VETERINARY ASSOCIATION

ALL things change, and the pace that's slow is often sure. The British people are unique in many ways and not the least of these is in being able to adapt to any circumstances or conditions that may arise. The British way of life can be moulded to suit any existing state of affairs, and exhibits a remarkable flexibility which enables us to accommodate any changes that may occur, be they introduced suddenly and out of dire necessity or otherwise.

This flexibility is no sign of weakness: rather it is a token of strength and character. It is born of the ability to see and give regard to the other fellow's point of view, and it has been nourished by the strong family feeling which pervades the Commonwealth. There are some who would call it the power to compromise, but compromise or not it has probably been one of the greatest factors in our evolution as a first-class nation and at the same time enables us to gain and keep the regard and respect of our contemporaries.

As a rule we do not change things suddenly, for our respect for tradition and sentiment holds us tightly in its bonds. This is good, for whilst the enthusiastic few may sometimes fret and fume, the great majority are loath to discard without due debate and consideration those things which have served well in the past.

Even in the lifetime of the present generation we have seen great changes in our mode of life and habits which in some other places could only have been brought about by revolution and force of arms. We appear to be experts in the gradualness of change. We are not prone to make much of great events, so that many fundamental changes have passed by almost unnoticed.

One is reminded of all these things on seeing a modest notice which reads as follows: "That the name of the Association be changed to The British Veterinary Association in 1952." This has not come about through some sudden impulse, for the fight has been one of many years, and the announcement is typical of the spirit of compromise for five years' notice of change is given. The fight—if one can call the cut and thrust of debate a fight—has been conducted with utmost decorum and great chivalry on all sides. Tradition, sentiment and the general desire to give no offence to the small opposition minority has been given full regard and has certainly delayed the change for ten to fifteen years.

XUM

It is our proud boast that the Commonwealth is one great family composed of many races and creeds, each unit independent, yet united in a common mother and aim. In like manner so are the members of the profession one great family, and they in turn look to the N.V.M.A. as the hub of all association activity within the Empire.

In these days of rapid transit and communication, the mother of all veterinary associations has a great part to play, not only with regard to the interests of its members but in the much wider sphere of the welfare of the Commonwealth. One would also like to see our Royal College widening its influence and scope in a similar manner so that it could become the very centre of and the prime authority in all matters dealing with Veterinary Education and Ethics.

Is it too much to hope that the examinations of the R.C.V.S., particularly those for the Fellowship, might be also conducted in our lands overseas? Standards could be set which would allow of the right to practise in any part of the Empire. The Fellowship of the R.C.V.S. could be made the "acme hallmark" of proficiency throughout the Commonwealth in the same way as the F.R.C.S. has become the premier human surgical distinction.

The modest notice means that the dreams of the seniors have at last become reality. Let us hope that the young men who follow will see visions and by going further make the R.C.V.S. and the B.V.A. the living centres of British Veterinary Science.

GENERAL ARTICLES

THE CONTROL OF THE SHEEP BLOWFLY WITH D.D.T. AND BENZENE HEXACHLORIDE (666)

By L. E. HUGHES, M.R.C.V.S., D.V.S.M. (Manc.), N.D.A.,[1] E. PARKER POLLARD, B.Sc. (Lond.),[2] H. I. FIELD, M.R.C.V.S.[3] and J. M. JONES, B.Sc. (Wales)[4]

EVIDENCE is accumulating that D.D.T. is of value in the control of the sheep blowfly. Since Cragg (1945) published evidence that the presence of D.D.T. in the fleece of sheep prevented oviposition by *Lucilia sericata*, a number of papers have appeared in this country on the control of the blowfly with this insecticide.

Harbour and Watt (1945) found that, of 40 lambs sprayed with D.D.T., none were struck during a period of 47 days as compared with 30 struck amongst 80 untreated control animals (37.5 per cent.). Cragg (1946) reported that, of 1,061 sheep dipped in D.D.T., 14 (1.3 per cent.) were struck during a period of 40 days as compared with 55 (5.2 per cent.) struck amongst 1,055 control animals treated in a proprietary dip. Hughes, Jenkins & Jones (1946) reported the results of a dipping trial conducted in mid-Wales, which showed that, over a period of observation of 33 days, 20 sheep were struck of 1,776 (1.1 per cent.) dipped in D.D.T., 18 of 567 (3.2 per cent.) dipped in an arsenical proprietary dip, while 38 strikes occurred amongst 493 (7.7 per cent.) untreated control animals. The results of a trial sponsored by the Agricultural Research Council were recently reported by Cragg (1947). This work, carried out in the summer of 1945, involved 38 farms and a total of 11,548 sheep and included the experiment already published by Cragg (1946). In this trial, 5,764 control sheep were dipped in a variety of proprietary dips, none of which contained D.D.T., and the remainder (5,784 sheep) in an experimental preparation giving a bath concentration of 0.5 per cent. D.D.T. The 38 farms in this experiment were distributed over a wide area of Great Britain, covered by three centres in Scotland, five in England, and one in Wales. The dips were therefore tested on a variety of breeds under a wide range of field conditions. The results showed that 2.6 per cent. of the controls and 0.8 per cent. of the sheep dipped in D.D.T. were struck during a period of observation of 42 days. These results are in close agreement with those of Hughes *et al.* (1946).

Less information on the value of benzene hexachloride is available. Harbour and Watt (1945) tested its efficiency as a spray, and found that, while less effective than D.D.T., it gave some reduction in the number of strikes compared with the untreated control group. They found that six strikes occurred in a group of 61 ewes and lambs sprayed in benzene hexachloride (10 per cent.) as compared with 18 strikes in a group of 60 control animals (30 per cent.). Somewhat similar results were obtained by Hughes *et al.* (1946) in limited dipping trials with a benzene hexachloride preparation, but, since only some 250 sheep were dipped in it, no definite conclusions were drawn.

(1) Ministry of Agriculture and Fisheries, Veterinary Investigation Department, Aberystwyth.
(2) Seconded to the Department of Animal Health, U.C.W., Aberystwyth, by the Cooper Technical Bureau, Berkhamsted, Herts.
(3) Ministry of Agriculture and Fisheries, Veterinary Investigation Department, Aberystwyth.
(4) Assistant Advisory Entomologist, N.A.A.S., Wales.

The preparation of D.D.T. used by Hughes *et al.* (1946) produced symptoms of skin irritation and intoxication. An experiment comparing this dip with a similar preparation not containing D.D.T. indicated that the solvent used was responsible for these symptoms, and it was considered by these authors that this feature made the dip unsuitable for general use. In view of these findings, a further experiment was planned for the summer of 1946, to attempt to confirm the results obtained in 1945 and to assess the value of D.D.T. using a formulation which did not include a solvent toxic to sheep. The experiment was extended to cover the use of benzene hexachloride on a comparable scale.

Materials and Methods

The dips used in the present experiment had the following characteristics:

D.D.T.—A fine suspension of D.D.T. containing 40 per cent. of total D.D.T. and approximately 32 per cent. of 1 : 1 : 1 trichloro 2 : 2 di-p-chlorophenylethane. Diluted, it provided a final bath concentration of 0.5 per cent.* of total D,D.T.

Benzene hexachloride.—A fine suspension of benzene hexachloride containing 40 per cent. of total benzene hexachloride and approximately 5 per cent. of the gamma isomer. Diluted, it provided a final bath concentration of 0.5 per cent.* of total benzene hexachloride and 0.0625 per cent. of the gamma isomer.

Arsenic.—A commercial preparation in the form of a powder dip containing arsenic and sulphur. The final bath concentration conformed to the regulations of the Ministry of Agriculture and Fisheries for the control of sheep scab, containing arsenic compounds equivalent to 0.19 per cent. arsenic trioxide ($As_2 O_3$).

The work was conducted on nine farms in mid-Wales; four of these were in Breconshire, three in Montgomeryshire, one in Radnorshire and one in Pembrokeshire. Flocks of various breeds were dipped, including the Improved Welsh, Clun Forest, Kerry Hill, and an exotic Spanish breed. The dipping baths, of varied design in brick or concrete construction, provided, in general, satisfactory facilities for the work; inadequate water supplies and drainage systems were the chief failings of the installations used. So far as was possible equal groups of ewes and lambs were dipped in each preparation on each farm; this was not always practicable owing to the grazing arrangements on particular farms. The final totals treated with each dip were as follows: D.D.T., 1,014; benzene hexachloride, 1,312; arsenic, 947. For reasons given later in the text, the results from one farm were discarded; the revised totals were then as follows: D.D.T., 868, benzene hexachloride, 1,093; arsenic, 859.

Dipping commenced early in June and was completed in about a month. Although ideally all the flocks should have been dipped within the space of a few days, this was not possible owing to varying dates of shearing from farm to farm. To provide for retention of dip in the fleece it was necessary to allow about three weeks' growth of wool to develop after shearing. Samples of wash were taken from all the baths immediately after mixing and at intervals during the dipping; the bath concentrations of D.D.T. and benzene hexachloride were determined by chemical analysis of the majority of these samples, and the results are given in

* As indicated later in the text, this concentration was not always obtained; occasionally the initial bath strength was either above or below the figure desired. The explanation for these slight discrepancies lies in the fact that in each case the figure given by the farmer for the capacities of the dipping bath was accepted by us without any attempt at checking his measurements.

Table IV. The period of immersion per sheep was not definitely standardised, but observations during the course of dipping showed it to be reasonably constant and to average about 20 seconds.

A book of printed forms was issued to the shepherd on each farm for recording post-dipping observations. These forms provided for information on the following points:

(i) Daily strikes on ewes and/or lambs in each group.
(ii) Location of each strike—body or breech.
(iii) Approximate weather conditions—by deletion from the following choices: Wet, Dry, Warm, Cold.

Provision was also made for a summary of any special points relating to the experiment—i.e., changes of grazing, deaths or sales of test animals, etc.—to be made at the end of each week. Periodical visits were made to the farms to review the position and collect the recorded information.

Although efficient and co-operative farmers were selected and in spite of this supervision, the returns did not always yield completely satisfactory data. On one of the nine farms included originally in this experiment, the group dipped in arsenic did not include any lambs; yet the returns indicated a number of strikes on lambs, and no convincing explanation of the discrepancy was given. These results were therefore suspect; not only is the data for the arsenic group unacceptable, but also the possibility is raised of confusion between the different groups. It is unfortunate that this should have occurred, since the test groups on this farm were large and the incidence of blowfly strikes was high; under the circumstances it has been considered advisable to reject all the results from this farm.

TABLE I.
SUMMARY OF RESULTS OF POST-DIPPING OBSERVATIONS ON EIGHT FARMS.

Dip	Farm	No. of Sheep Dipped	Degree of Protection 33 days No. of strikes	%	46 days No. of strikes	%	First Strike (Days after Dipping)	Average Duration of Protection in Days 33-day period	46-day period
D.D.T.	1	64	—	—	—	—	42	33.0*	—
	2	98	1	1.0	1	1.0	29	29.0	29.0
	3	142	5	3.5	—	—	23	28.4	—
	4	63	—	—	—	—	46*	33.0*	46.0*
	5	135	—	—	—	—	55*	33.0*	46.0*
	6	190	—	—	—	—	49*	33.0*	46.0*
	7	107	—	—	2	1.9	37	33.0*	40.5
	8	69	—	—	—	—	46*	33.0*	46.0*
B.H.C.	1	197	3	1.5	—	—	15	15.0	—
	2	105	7	6.6	11	10.5	14	28.4	33.5
	3	155	14	9.0	—	—	25	28.8	—
	4	115	7	6.1	8	6.9	25	25.5	27.8
	5	147	4	2.7	6	4.0	12	24.5	29.6
	6	200	4	2.0	4	2.0	5	15.7	15.7
	7	106	2	1.9	8	7.5	17	20.0	39.0
	8	68	2	2.9	6	8.8	18	19.0	37.0
Arsenic	1	88	—	—	—	—	38	33.0*	—
	2	68	7	10.3	7	10.3	28	29.5	29.5
	3	141	11	7.8	—	—	30	30.8	—
	4	109	23	21.1	27	24.7	18	20.7	24.0
	5	144	—	—	—	—	55*	33.0*	46.0*
	6	128	5	3.9	5	3.9	7	26.0	26.0
	7	113	1	0.9	4	3.5	23	23.0	40.2
	8	68	4	5.9	4	5.9	13	15.5	15.5

* These figures are the maximum periods of observation for the farms concerned, i.e., no strikes occurred in the test groups during the course of the experiments, and the duration of protection as given by these figures, may therefore be under-estimated.

TABLE II.

MEANS OF THE RESULTS ON EIGHT FARMS.

Dip	No. of Sheep Dipped	Degree of Protection: 33-day period No. of strikes	%	46-day period No. of strikes	%	Time of First Strike (Days after Dipping): Min.	Max.	Mean	Average Duration of Protection (All Strikes): 33-day period	46-day period
D.D.T.	868 (662)	6	0.6	3	0.5	23	55*	40.9	31.9	42.3
B.H.C.	1,093 (741)	43	4.1	41	6.6	5	25	16.4	22.1	30.4
Arsenic	859 (630)	51	6.2	49	8.1	7	55*	26.5	26.4	30.2

NOTE. (1) Figures in parenthesis in Column 2 refer to the 46-day period, and the remainder to the 33-day period.

(2) Figures marked * are equal to the period of observation for the group concerned and may be under-estimated. (See text.)

(3) Figures for percentage struck and duration of protection are the means of the similar figures for individual farms, and are not derived from the final totals, because of variation in the sizes of dipped groups and other factors from farm to farm.

TABLE III.

FARM No. 2. (Period of observation 60 days).

			No. Dipped.	No. Struck.	% Struck.	Average Duration of Protection (in days).
D.D.T.	Ewes	Body ...	49	2	4.1	60
		Breech ...		1	2.1	29
	Lambs	Body ...	49	0	0	>60
		Breech ...		1	2.1	60
	Total and Means ...		98	4	4.1	50
B.H.C.	Ewes	Body ...	70	15	21.4	59
		Breech ...		8	11.4	29.5
	Lambs	Body ...	35	8	22.8	53.6
		Breech ...		2	5.7	36.5
	Total and Means ...		105	33	31.4	44.7
As	Ewes	Body ...	68	4	5.9	60.8
		Breech ...		7	10.3	29.6
	Total and Means ...		68	11	16.2	45.2

Results

A summary of the results from individual farms is given in Table I, and the final average figures for the whole experiment are given in Table II. The latter are also shown graphically in Figs. 1 to 3.

Methods of Calculation

Under " Degree of Protection," the number of strikes in each group has been expressed as a percentage of the number of sheep dipped. Two sets of figures are given, corresponding to the incidence of strikes during the two periods of observation adopted—i.e., 33 and 46 days after dipping.

The " Duration of Protection " has been assessed in two ways:

(a) The time, in days after dipping, before the first strike in each group occurred. This is given in terms of minimum, maximum and mean times.

(b) The average duration of protection, which is the mean time, in days, between dipping and the occurrence of all the strikes in each group.

With field experiments of this nature it is impossible to calculate a single figure to cover all aspects of the effect of a dip. None of the above methods of assessment is in itself ideal, but, considered together, they give a reasonably comprehensive picture of the results.

FIGURE 1

Degree of Protection. Mean Percentage Struck in Dipped Groups on Farms 1 to 8

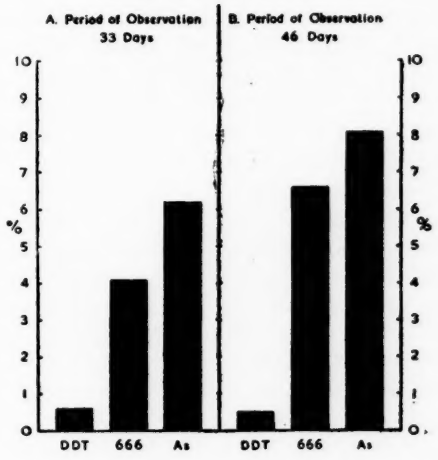


FIGURE 2

Duration of Protection. 1. Occurence of 1st Strike on Farms 1 to 8

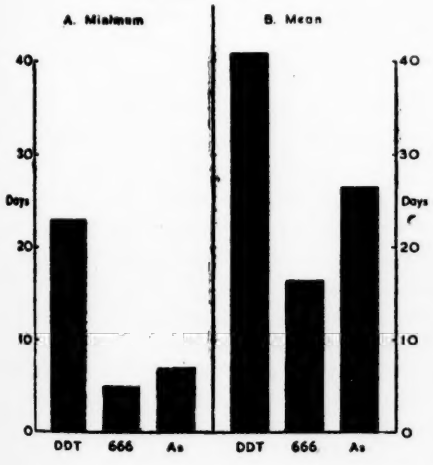
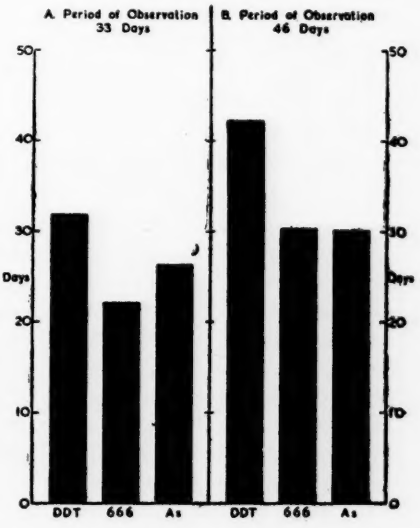


FIGURE 3

Duration of Protection. 2. Mean Time After Dipping for All Strikes on Farms 1 to 8



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Discussion

The figures given for the duration of protection are under-estimated for D.D.T., and, to a smaller extent, for arsenic also. This is inevitable with the present method of calculating this result in all groups where no strikes occur during the periods of post-dipping observations. When this occurred, a minimum figure equal to the number of days in the period of observation has been given in order to provide some basis for calculating the final mean. The resultant bias will thus increase in proportion to the number of farms with no strikes; it is most evident with D.D.T. (six of eight farms negative in the 33-day period and four of six in the 46-day period), less so with arsenic (two of eight farms negative in the 33-day period and one of six in the 46-day period), and does not arise at all with benzene hexachloride. It will be seen that any allowance made for this bias would alter the final picture only to the extent of emphasising differences already apparent.

The general trend of the results shows clearly that D.D.T. was the most efficient dip tested. It gave an excellent degree of protection and was far superior to either benzene hexachloride or arsenic. Table II shows that, on the farms observed for 33 days of the sheep dipped in D.D.T., 0.6 per cent. were struck; in benzene hexachloride, 4.1 per cent.; and in arsenic, 6.2 per cent. The corresponding figures for the farms observed for 46 days are: D.D.T., 0.5 per cent. struck; benzene hexachloride, 6.6 per cent.; and arsenic, 8.1 per cent.

For *duration of protection* D.D.T. was again superior, but the order of efficiency of benzene hexachloride and arsenic was reversed, viz.:

Minimum Time for First Strike		*Mean Time for First Strike*	
D.D.T.	23 days	D.D.T.	40.9 days
Benzene hexachloride ...	5 „	Benzene hexachloride ...	16.4 „
Arsenic	7 „	Arsenic	26.5 „

The same trend is shown to a smaller extent by the figures for *average duration of protection*, viz.:

Farms observed for 33 days		*Farms observed for 46 days*	
D.D.T.	31.9 days	D.D.T.	42.3 days
Benzene hexachloride ...	22.1 „	Benzene hexachloride ...	30.4 „
Arsenic	26.4 „	Arsenic	30.2 „

Table III demonstrates a fact of some importance in the control of the sheep blowfly. These results from Farm No. 2 show that the duration of protection given by all three dips against body strikes was approximately double that against breech strikes. This relative proportion, independent of the type of dip used, is almost certainly due to the attractant effect of contamination of the wool by fæces and urine in the breech region. It is a clear indication that any insecticidal treatment is unlikely to give effective control unless it is supplemented by crutching to minimise soiling of the breech. This indication is common to the seven farms where full records of the positions of strikes were kept; of a total of 152 strikes, 34 occurred on the body and 81 on the breech of ewes, the corresponding figures for lambs being 14 and 23. The difference therefore applies to the degree as well as the duration of protection.

Results of the analyses of dip wash samples (Table IV) show that a satisfactory concentration of the active principle was maintained in all the benzene hexachloride baths, whether or not replenishment occurred, and that at least 200

sheep could be dipped without seriously reducing this concentration. The same is true of the D.D.T. baths, but it will be noted that in the case of two farms (Nos. 6 and 8) the initial bath strength was slightly below that desired. The maintenance of the bath concentration throughout the course of dipping is a factor of considerable importance. The complete absence of strikes in the D.D.T. groups for 46 days after dipping on farms 6 and 8 indicates that concentrations as low as 0.35 per cent. D.D.T. will give full protection. Three of the five benzene hexachloride baths were considerably over-strength (approximately 0.6 per cent.); this emphasises the failure of this dip, compared with D.D.T.

TABLE IV.

BENZENE HEXACHLORIDE.

Analyses of Samples of Bath Washes.

No. of Farm.	Approximate volume of bath wash.	Description of Sample.	No. of Sheep.	B.H.C.
7	240 gals.	Initial	—	0.56%
		Final	106	0.52%
5	240 gals.	Initial	—	0.57%
		After 60 gal. replenishment ...	55	0.61%
		Final	147	0.63%
6	240 gals.	Initial	—	0.48%
		Final	200	0.42%
1	220 gals.	Initial	—	0.61%
		After 40 gal. replenishment ...	66	0.57%
		After 40 gal. replenishment ...	134	0.50%
		Final	227	0.45%
8	220 gals.	Initial	—	0.44%
		Final	68	0.43%

D.D.T.

Analyses of Samples of Bath Washes.

No. of Farm.	Approximate volume of bath wash.	Description of Sample.	No. of Sheep.	D.D.T.
7	270 gals.	Initial	—	0.50%
		Final	107	0.48%
5	250 gals.	Initial	—	0.53%
		After 60 gal. replenishment ...	51	0.59%
		Final	135	0.52%
6	240 gals.	Initial	—	0.41%
		Final	190	0.36%
1	240 gals.	Initial	—	0.53%
		Final	94	0.51%
8	200 gals.	Initial	—	0.34%
		Final	69	0.37%

In the trials reported by Cragg (1947), the incidence of strikes amongst the control sheep dipped in arsenic was about 3 per cent. compared with about 1 per cent. in the sheep dipped in D.D.T. Such a low incidence in the control sheep, combined with the failure of D.D.T. to achieve absolutely complete control during a period of six weeks, naturally raises the issue of the economic value of D.D.T. dips against sheep blowfly in view of the time, labour and expense involved.

On the basis of his results, Cragg (1947) is concerned about this aspect of the problem and he wonders if the partial protection afforded by D.D.T. in relation to the total cost of control justifies its use. In the experiment conducted in this province during the summer of 1946 the position was quite different. The incidence amongst the sheep dipped in arsenic (comparable to Cragg's controls) was 8.1 per cent. over a period of observation of 46 days, with a range on individual

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farms from 0 per cent. to 24.7 per cent. Moreover, it has been shown (Hughes *et al.*, 1946) that the arsenical proprietary dips marketed for the control of the sheep blowfly provide some degree of control, in comparison with the incidence of strikes on untreated sheep. Furthermore, it is possible as suggested by Hughes (*et al.*, 1946) that the D.D.T. present in the wool of sheep dipped in this substance, resulted in a reduction in the fly population in the areas over which all groups were running. Thus, a fly alighting on a D.D.T.-dipped animal would be killed and so prevented from ovipositing on another sheep as it might well do in the normal course of events. Again, these workers have pointed out the possibility of the transference of D.D.T. to other groups after dipping. If there is any truth in these suggestions, the full value of the D.D.T. treatment is not brought out by the simple differences in incidence of strikes between the D.D.T.-dipped sheep and the other two groups where all are running together.

The superiority of D.D.T. may therefore be considerably greater than is indicated by the figures given here. In view of these findings and the results here reported, it seems highly probable that the general incidence of blowfly strike in this country is sufficiently high to justify the expense of dipping now that the efficiency of D.D.T. for the control of the sheep blowfly has been confirmed by several workers. The incidence of strikes in the sheep dipped in D.D.T. this year was very much lower than in the sheep dipped in arsenic, and this result, at a time of the year when labour is needed for other essential tasks on the farm, should prove of real value and must be borne in mind when considering the total cost of control.

It will also be seen from the results of this trial that, of the eight flocks under observation for 33 days, six were completely protected from strikes; while, of the six farms observed for 46 days, four were completely protected for the whole of this period. The reasons for the failure of D.D.T. to afford complete protection on all farms are not clear, but it is quite certain that a number of factors influence the effectiveness of this substance under field conditions. Not the least of these factors is the intelligence and the ability of the shepherd; it is probable that D.D.T. will prove most effective in well-managed flocks. It has been suggested by one farmer taking part in this work that the lambs dipped in D.D.T. increased in weight more rapidly than the lambs in the other two groups. No figures were available to support this contention, but it is felt that this aspect of the problem might be investigated with advantage.

Benzene hexachloride proved a comparative failure. However, both benzene hexachloride and D.D.T. are insecticides of recent origin and their efficiencies may well be increased by improved methods of formulation.

Summary

(1) Field dipping trials, involving some 3,000 sheep and lambs, for the control of the sheep blowfly *L. sericata* are reported.

(2) For this work, which was done in mid-Wales in the summer of 1946, dispersible preparations of D.D.T. and benzene hexachloride were used, control sheep being treated with a proprietary arsenic-sulphur powder dip.

(3) Of these preparations, D.D.T. was outstandingly superior in both the degree and duration of protection afforded. Benzene hexachloride gave a slightly higher degree of protection than arsenic, but for a shorter period. Of the sheep dipped in D.D.T., 0.5 per cent. were struck; in benzene hexachloride, 6.6 per cent.;

and in arsenic, 8.1 per cent. Amongst the eight flocks under test, during a period of 33 days after dipping, six were completely protected from strikes by D.D.T., two by arsenic, but none by benzene hexachloride.

(4) It is concluded that the economic value of dipping with D.D.T. for the control of the sheep blowfly is justified by these results. This conclusion is qualified by the recommendation that any insecticidal treatment should be supplemented by efficient crutching to prevent contamination of the breech region by fæces and urine serving as an attractant to the blowfly.

Acknowledgments

We wish to express our indebtedness to the farmers who collaborated with us by placing their flocks at our disposal. We also place on record our thanks to Messrs. Cooper, McDougall & Robertson, Berkhamsted, Herts, for supplying the dips for this work; and to Mr. W. S. Manson, of the Cooper Technical Bureau, who was responsible for the chemical analyses of the wash samples.

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POISONING BY CASTOR SEED

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ALTHOUGH the castor oil plant, *Ricinus communis,* and the medicinal value of the oil obtained from it have been known from remote antiquity, the poisonous property of the seeds appears to have escaped notice until comparatively recent times. Both Pliny and Herodatus refer to the oil, and castor seeds have been found in an Egyptian sarcophagus 4,000 years old, yet it is not until the eighteenth century that we find any record of their toxicity.

The seeds, from which the castor oil of commerce is expressed, vary greatly in size and colouring. They are usually 1-1.8 cm. in length, and present a mottled appearance, the ground colour ranging from pale pink or buff to black, streaked with red or brown. According to Agulhon (1914) there is no difference in toxicity between the seeds of the various known sub-species, although Lander (1914) states that large seeds are more poisonous than small ones. The oil itself is non-toxic, as the active principle—ricin—is not soluble in it, but the residue left after extraction of the oil ("Pomace" or "Castor-cake") is extremely poisonous, and many accidents have arisen from its admixture in feeding stuffs through ignorance, carelessness, or deliberate malice.

Animals vary between wide limits in their susceptibility to the poison. In the horse, Bornemann (1922) found that whereas 0.007 gms. of the seed per kilo of body weight may cause death, 0.2 gms. may cause no symptoms whatsoever, and even 0.3 gms. is not always lethal. With rabbits, Miessner (1908-09) found that 28 per cent. of the animals were killed by 0.4 gms. per kilo, 40 per cent. by 0.5 gms., and 83 per cent. by 0.75 gms., but that 1.25 gms. per kilo was necessary to

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be certain of producing death. This means that the figures usually given for the lethal dose, and obtained from experiments on a limited number of animals, are not very reliable. It seems definite, however, that the horse is the most susceptible animal, sheep, cattle and pigs being more resistant, and ducks and poultry more resistant still.

A noticeable feature of castor seed poisoning is that, no matter how great the quantity eaten, there is a definite interval between the ingestion of the poison and the onset of symptoms. This is usually several hours, but may be as much as two or three days (McCunn, 1945). According to Cornevin (1897b), it is never less than 48 hours in birds.

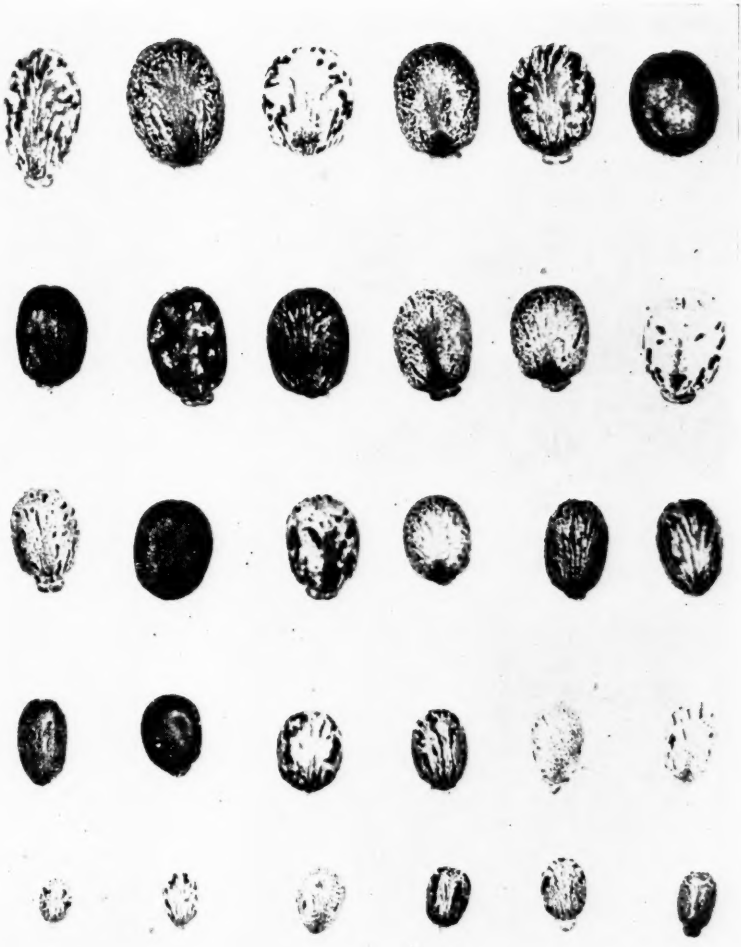
Most of the cases of poisoning that have arisen in this country have occurred in horses. The symptoms are generally colic, loss of appetite, cramp, and twitching of the muscles. The animal stands dejectedly and only moves unwillingly. Diarrhœa is generally present, and McCunn (1945) notes that when the onset of this is delayed, recovery takes longer. Broad (1896), however, records constipation in one case of poisoning, and Wood (1918) noticed that horses are usually constipated after recovery. Cornevin (1897b) found that boiled (non-toxic) castor meal causes constipation and suggests that this is due to a different substance.

Several authorities have noticed "tumultuous" heart beats, that shake the whole animal. The temperature is usually slightly raised, but Wooldridge (1918) says that it bears no relation to the severity of the symptoms. The pulse is frequently hurried and weak, the breathing shallow and rapid.

The *post-mortem* findings usually show the mucous membrane of the stomach as reddened and œdematous, and this inflammation extends some distance along the gut, where punctiform hæmorrhages are often observed. The mesenteric lymph glands are swollen, and there are frequently inflammatory lines along blood vessels and lymphatics of the mesentery. Liver, kidney and spleen are often swollen and œdematous, but may show no changes. The lungs are sometimes filled with frothy fluid.

The treatment of poisoned animals has usually been along general lines. The correct antidote is, of course, the specific antiserum, but this is unlikely to be available in sufficient quantity, if at all. In default of this, warmth and sedatives (McCunn, 1945), sulphuric ether and strychnine (Wooldridge, 1918) have been used, while in human cases the treatment has usually consisted of evacuation of the stomach, followed by morphia and brandy. In this connection, it is worth noting that Simpson and Banerjee (1932), while investigating the poisoning of horses in India by *Abrus precatorius* seeds, found injections of arecoline hydrobromide followed by saline purges to be most efficacious. As *Abrus precatorius* (Jequerity) seeds contain a phytotoxin, abrin, almost indistinguishable from ricin, it seems likely that arecoline hydrobromide might be useful in cases of castor seed poisoning.

Poisoning in human beings follows a very similar course to that in animals. Man seems to be very susceptible, as two seeds have been known to cause death in one case (Meldrum, 1900), and three in another (Christison, 1861). Kobert (1906) states that the lethal dose is in the neighbourhood of one milligram per kilo, but the same variability is shown as with animals. Bisham (1903) records a case in which a party of convicts in Cuba ate seeds from a castor tree. Some men, who had eaten from one to six seeds, were desperately ill, while others, who had eaten



SPECIMENS OF CASTOR BEANS
Showing Variations in Size and Markings

over a hundred, suffered no ill-effects. The symptoms generally consist of vomiting and purging, intense pain and tenderness in the epigastric region, cramp in the limbs, low surface temperature, and collapse. The *post-mortem* findings resemble those in animals.

Ricin, the toxic principle of the seed, belongs to the group of plant poisons known as the "phytotoxins" or "toxalbumens.' It was first extracted and investigated in detail by Stillmark (1889), and subsequently by many other workers, among them Osborne, Mendel and Harris (1905), whose method of extraction forms the basis of that now generally employed. Briefly, it consists of extracting the crushed oil-free seeds with ten per cent. sodium chloride solution, dialysing to remove globulin, fractional precipitation with ammonium sulphate (the fraction that is precipitated between one-third and one-fifth saturation being the most toxic), redialysing to remove the salt, and finally evaporating at low temperature *in vacuo*. Obtained in this way, ricin is a yellowish white powder, readily soluble in water. The solubility and toxicity decrease on keeping.

Most authorities agree that ricin is protein in nature, and Karrar *et al.* (1924) showed that on hydrolysis it yields a mixture of amino acids such as one would expect to find in a vegetable albumen. Its solutions show all the ordinary protein reactions, and are coagulated by heat, this coagulation being accompanied by complete loss of toxicity. Hence material containing castor seed is quite harmless if it has been boiled.

The main characteristic of ricin is its striking toxicity, preparations with a minimum lethal dose of less than 0.0001 mg. per kilo having been recorded (Field, 1910). Although some of these "astronomical" figures must be accepted with reserve, owing to the methods of dilution employed, the fact remains that this substance is one of the most poisonous known.

Much work has been done on the experimental poisoning of animals with ricin. The toxicity by injection is over a hundred times greater than per os, the route (intravenous, subcutaneous, etc.) making little difference. In the main, the symptoms are similar to those already described, except that the lethal dose by injection is a far more constant quantity, suggesting that the variable factor is the ease with which the ricin is absorbed from the alimentary canal. There is the same "latent period," a mouse that has been injected with a million lethal doses of ricin showing no symptoms for several hours and dying no more quickly than one that has received only one-thousandth of this quantity, although with smaller doses the period becomes longer—up to several days. During this latent period, the animal seems perfectly normal. It then begins to lose weight rapidly, at a rate that cannot be accounted for by any diarrhœa that may set in, and which is actually greater than would occur in starvation (Lander, 1914). The symptoms then appear suddenly. Clonic convulsions set in, and the animal falls on its side. After a few minutes the spasms give way to a state of flaccid paralysis. Then the convulsions start again, and so on until the animal dies, usually an hour or so after the onset of symptoms. According to Müller (1899) there is a gradual fall in blood pressure, pulse rate, and rate of respiration during this last stage.

The chief gross pathological changes found on *post-mortem* examination consist of punctiform hæmorrhages in the stomach and small intestine, swelling and reddening of Peyer's patches and the mesenteric lymph glands, enlargement of the spleen, and focal areas of necrosis in the liver. The histological changes caused

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by ricin intoxication have been studied in great detail by Flexner (1897), who describes a picture of widespread cell disintegration, lymphoid cells being particularly implicated. The lymph glands show degenerative changes, in extreme cases nothing being left of the original normal tissue of the gland. In the intestine and stomach the epithelium is the chief site of damage, the protoplasm being granular and opaque and neighbouring cells partly fused together. The splenic pulp contains huge macrophages, enormously distended with cell debris. In the liver, in addition to general swelling and fatty degeneration, there are definite areas of necrosis, death of the cells being due to compression of the capillaries. The nuclei of the cells are frequently fragmented, and the lymphatic spaces full of nuclear detritus. The kidney is less affected, though the tubular epithelium shows some fatty degeneration and necrosis. The lesions in the brain have been described by Berkley (1896), who found the same evidence of cell disintegration.

The abdominal lesions, which are always present to a greater or less extent, are independent of the route or site of injection. They are probably associated with the elimination of the poison, which, according to Stepanoff (1896), takes place via the gut.

In addition to the general action on the organism, a drop of ricin solution placed in the eye causes intense inflammation, followed in extreme cases by blindness.

If ricin is added to defibrinated blood or to a suspension of red blood corpuscles, the latter are agglutinated. This phenomenon was first discovered by Stillmark (1889), and has been extensively studied since his day. Suspensions of other body cells—liver, spleen, brain and so on—are also agglutinated (Michaelis and Steindorf, 1907), as well as carmine and cholesterol suspensions (Gunn, 1920). The blood of some species is much more easily agglutinated than that of others, rabbits' red cells, for example, being very susceptible, while those of sheep and cattle are much more resistant. Agglutination only takes place in the presence of electrolytes (Rona and Gyorgy, 1920), and is apparently due to the adsorption of ricin interfering with the lyophilic properties of the cell-liquid interface, thus rendering the particles more sensitive to the action of ions.

Ricin resembles the bacterial toxins in being antigenic, Ehrlich (1891) having shown that animals fed or injected with small quantities become immune to very large doses. This immunity is quite specific, as an animal immunised against ricin is not protected against abrin and *vice versa*. The antigenic factor is much more stable than the toxic one, as ricin that has been detoxicated by heat (Cornevin, 1897a), or by a variety of chemical agents, such as formaldehyde (Heymans, 1926), potassium permanganate, or sodium ricinoleate (Carmichael, 1926 and 1929) is still capable of conferring immunity.

When the serum of an immune animal is mixed with a solution of ricin, a precipitate is formed, as in the case of bacterial toxins (Jacoby, 1901). By continued injection of ricin over long periods sera of very high potency may be obtained, one ml. neutralising over 12,000 M.L.D. in mice. It is a matter of controversy as to whether or not the serum contains a specific anti-agglutinin.

As ricin possesses no distinguishing chemical properties, its detection in feeding stuffs and abdominal contents is a matter of great difficulty. The three methods which have been used for its identification are: (1) microscopic examination; (2) the agglutination test; and (3) the precipitin test.

The first of these is simplified by Leather's (1892) discovery that, if the suspected material be treated with bleaching powder after preliminary boiling with acid and alkali, almost the only substance remaining unbleached is the testa of the castor seed. These dark particles can be picked out and examined in detail. The method was elaborated by Dodd (1932), who found that in addition to castor seed, croton, curcin, grape, and ucahuba also escaped being bleached, although the fragments could be differentiated by microscopic examination. The method is, however, unsatisfactory for a number of reasons, chief of which is the fact that it is only the presence of the non-toxic testa that is confirmed. This would be found in boiled, non-poisonous castor meal, but not in cake made from highly toxic decorticated seeds.

The second method, that of finding whether an extract of the suspected material will agglutinate red blood cells, is also unsatisfactory. Firstly, it is not specific, as many plants contain non-toxic agglutinins (Mendel, 1909). Secondly, it is not delicate enough, the quantity of ricin needed to bring about agglutination being greatly in excess of the lethal dose. In this connection, a micro-agglutination method recently described by Karel and Franklin (1946) might prove of value, but the problem of the non-specificity remains.

The third method, the production of a precipitate when a solution containing ricin is mixed with the serum of an immunised animal, has the advantage of being specific but is still not delicate enough. Lander and Geake (1914) found that they could not detect ricin by this means in the omasum of an experimentally poisoned calf.

As all these methods are unsatisfactory, the best procedure is to make use of the protective effect of the immune serum. The suspected material is extracted with saline and concentrated, if necessary, by precipitation with ammonium sulphate. Two similar series of dilutions of the extract are then made. To each tube of the first series (A) is added a small quantity (say 0.2 ml.) of serum from an immunised animal. To each of the second series (B) is added a similar volume of normal saline. Both series are then injected into mice. If series B shows an appreciably greater mortality than series, A, the original material must contain ricin, as the serum is quite specific, and would not protect against any other poisonous substance.

Acknowledgments

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TRACE ELEMENTS IN PLANT AND ANIMAL NUTRITION

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Introduction

THE importance of the mineral elements in plant as well as animal nutrition has long been recognised, but, naturally enough, main interests have been focussed on the commoner or "principle" representatives, such as calcium, magnesium, sodium, potassium, phosphorus, etc., which occur in relatively large quantities and display more obvious roles in the various life processes.

It is not surprising that, with 96 known elements in the Periodic Classification, a very large number of these—including "principle" ones—should be found in plant and animal tissues, many of them participating in very definite metabolic processes, some merely existing in biological systems as fortuitous occurrences with no apparent useful, or even deleterious, functions.

During the last decade, considerable progress has been made in the development of microchemical and spectrographical methods of analysis, and this has led to the revelation of the presence, and often importance, of an increasing number of elements whose concentrations in living tissues are very minute; these are commonly referred to as "trace" elements in contradistinction to the so-called "principle" elements.

It is not the purpose of this article to present an exhaustive account of all that is known about the biological roles of these substances, but rather to emphasise their function in the all-important interrelationship between plant and animal metabolisms. Too often there is a tendency to consider trace elements merely in connection with animal health without paying enough attention to the plants which form essential parts of the animals' diet and from which they derive the bulk of their minerals—both principle and trace.

It is generally true to say that good health in plants will foster good health in the animals which feed on them, and it is this theme which it is proposed to expand to a much greater extent.

Our knowledge of the relations of trace elements in plant metabolism is much

greater than in animals; this is due, primarily, to two main causes. Firstly, the relatively easy experimental procedures that can be applied in the study of plant metabolism; and, secondly, the difficulty of preparing highly purified animal diets for nutritional experiments. As an example, the exclusion of all traces of, say, sodium chloride from an experimental diet is extremely difficult, for not only is this common material liable to be present in "traces" in the so-called "NaCl-free Salt Mixture," but it may also be present even in the protein, fat and carbohydrate supplements. Quite obviously this would be a considerable drawback in the study of the intermediate metabolism of sodium or chloride where it would be necessary to have a diet absolutely free of these elements. Then, too, there is the question of the contamination by other elements, and, for an example, let us return to sodium chloride. This substance, even when of analytic reagent quality, may contain traces of bromide, magnesium, calcium, which although present in very small quantities may tend to upset a particular nutritional investigation.* These difficulties are not insurmountable, and as research proceeds more and more "perfect" experimental diets are being produced which can allow work to be extended from laboratory rat colonies to the more immediately important farm and domestic animals.

The first real impetus to the study of trace elements was given about 50 years ago by Baumann's discovery of the element iodine in thyroid. Later, in 1913, Osborne and Mendel began their classic experiments on a search for the perfect salt mixture based on that normally found in cow's milk, and in 1918 they announced their Mixture IV, which, when treated with traces of aluminium, manganese and fluorine, was remarkably successful in supporting nutrition. Later, McCollum presented evidence to show that he could obtain successful nutrition by use of a similar mixture but without the addition of these traces; this is an obvious case of an "impure" salt mixture and there is some doubt as to whether the preparations were "pure" or that, in fact, they did contain those "traces" now considered necessary for animal nutrition.

An interesting forecast was made nearly 40 years ago by Albu and Neuberg, who stated that plants would contain all those elements of the soil in which they grew. This has been proved correct by many investigators, and even the most minute traces of elements in the soil can be extracted and stored by the plant.

Within recent years spectrographic analysis has revealed the presence of no less than 55 elements in plant and animal tissue, not all found in all living tissues but distributed in puzzling and often unaccountable ways. Drea, in an analysis of milk, has identified, besides the common elements, aluminium, boron, barium, chromium, fluorine, lead, lithium, molybdenum, silver, rubidium, silicon, strontium, tin, vanadium, titanium and zinc, making a formidable list of all elements to be 30 or over. In addition, plant and animal tissues have been shown to contain bromine, cobalt, nickel, selenium, bismuth, arsenic, tellurium, etc.

Wide surveys have been made by Webb and by Fox and Ramage of the mineral contents of a vast number of plant and animal tissues, and from their researches

* To illustrate the degree to which impurities may contaminate even substances of analytical reagent purity, the following example is given of "A.R. Sodium Chloride—Maximum Limits of Impurities": Cl—0.002 per cent. SO_4—0.003 per cent. NO_3—0.001 per cent. NH_3—0.0002 per cent. SiO_2—0.005 per cent. Al_2O_3—0.001 per cent. Pb—0.0005 per cent. Fe—0.0005 per cent. As_2O_3—0.00003 per cent. Quite obviously, if the metabolism of any of these contaminating elements was under study, even this A.R. specimen of salt could not be incorporated in an animal's diet without further (and laborious) purification.

many interesting facts have emerged. Two only will be mentioned. Firstly, the elements nickel and cobalt—of considerable importance to many of the higher animals—are indetectable in sea water, but in spite of this two species of sea-inhabiting gastropoda have been found, one which contains nickel and the other cobalt. This interesting fact illustrates the power of the living organism to withdraw from its environment substances which are present in extremely low concentrations and then to store them in significant quantities for its own metabolic uses. The second point of interest is the study of vanadium, which was identified in the blood of Ascidians by Heinz in 1911 and now identified in yet another species—a mollusc named *Pleurobranchus*. Although this may seem a far cry to the more obviously practical aspects of, say, veterinary nutrition, the scientist is bound to ask the question: if this element is apparently essential for the life of a lower invertebrate, does it fill a positive role in the life processes of higher animals where we know it is actually present? This is one of the hundreds of questions that can be asked and merely serves as an illustration of the vastness and significance of this aspect of nutrition.

Of direct importance to the veterinary and agricultural worker can be quoted the interesting and vital researches of Sjollema in 1933 and subsequent years on the role of copper as an essential element to both plants and to the animals feeding on them (Reclamation Disease and Lecksucht); the work of Elvejhem *et. al.* on the more intimate function of copper as an essential substance in the formation of hæmoglobin: and, finally, the researches of Dunlop *et al.* (1937), Bennetts and Chapman (1937) on the all too prevalent and widespread condition of swayback in lambs which appears to arise as the result of copper deficiency in the soil.

There is practically no limit to the examples which could be given, but these should be adequate to stress the importance of the trace elements in all phases of nutrition at all levels of living organisms.

Definition and Distribution

Very few, if any, textbooks can supply an adequate definition of the term trace element, and the average reader is left, not with a precise formulation but with a loose list of elements. This state of affairs is unavoidable and inevitable, for, as we shall see, what is considered a trace element to one animal may not be present in another and may even be a principle element in a plant, and from the arithmetical, functional and distributional points of view no hard and fast standardisation of terms is possible. It is more true to say that a trace element can be described rather than defined. In order to give the reader some fundamental ideas of the *biological* nature of a trace element the following general properties are suggested as a basis.

A trace element

(1) Is present in living tissues in quantities which are very small in comparison with those of the principle elements of the tissue.

(2) Does not normally form part of the main structural and functional tissues of an organism.

(3) May function as a useful adjunct, or a harmful "poison," or even as an "impurity" in a biological system. The nature of the function is generally dependent on the chemical constitution, and the relative

concentration of the element in the environment where the system exists.

(4) When present in excess may prove toxic.

Up to the present nothing has been said about actual quantities, and although we cannot formulate rules from the facts it will be as well to study some relative quantities in plants and animals. Table I gives an *average* elemental distribution —principle and main trace—in higher animal body; in addition, elements principle to plants marked (P).

TABLE I.

	Element	*Function in animal*	*Percentage of Total Weight*
Generally recognised "principle" elements	(P) Carbon	Form the "Organic" constituents, e.g., muscle, skin, nervous tissue, etc., also water.	65
	(P) Oxygen		18
	(P) Hydrogen		10
	(P) Nitrogen		3
	(P) Sulphur		0.25
	(P) Calcium	Skeletal tissues, bone, teeth, etc.	2
	(P) Phosphorus		1.1
	(P) Magnesium		0.05
	Sodium	Essential electrolytes.	0.15
	(P) Potassium		0.35
	Chlorine		0.15
	(P?) Iron	Hæmoglobin.	0.004
More important trace elements	Manganese	See Table IV	0.0003
	Copper	" " "	0.00015
	Iodine	" " "	0.00004
	Cobalt	" " "	Very variable and probably of the order of iodine, or even much less
	Zinc	" " "	
	Many other trace elements	" " "	

As will be seen, the "ash" or mineral fraction of the whole animal is of the order of 3-5 per cent. of the total weight, and of this the principle minerals take the lion's share with well over 98 per cent. To take a tangible example, let us imagine a horse weighing 750 kilos with copper content of 0.00015 per cent. By simple calculation, this will represent a concentration of 0.15 mgm. copper per gm. body wt.—assuming perfectly even distribution—which, in fact, is never the case. However, when comparison is made with, say, chloride, which in the same horse and with a concentration of 0.15 per cent. would give 150 mgm. per gm. body wt., the comparison in concentrations is considerable, one element being present in 1,000 times the quantity of the other. When plants and animals are compared even greater divergence is seen, as, for example, in the case of aluminium, a much-discussed element in view of its wide domestic use. This mineral accounts for 57 per cent. of the ash of the common fungus *Lycopodium* (i.e., 570 mgm./gm. wt. ash), whereas in animal brain it is only present to the extent of 0.002 mgm./gm., and much less in other tissues, an enormous difference only serving to emphasise the futility of attempting to make any mathematical generalisations.

Quite clearly there is a greater degree of standardisation in elemental composition amongst domestic animals than among the plants, and although there are very great differences in the distribution of certain trace elements in the

TABLE II.

Element	*Measurement*	*Wheat*	*Potato*	*Cabbage*
Fe	mgm./100 gm.	5.0	1.1	0.5
Cu	mgm./100 gm.	0.4	c0.1	c0.1
I	p.p.m.	4-9.0	10-700	776

TABLE III
Known micro-nutrient (trace) elements in plants.

Element	*Believed to be essential for at least the following plants*:*	*Possible Biological Function in Plant*	*Deficiency Signs, Symptoms and Diseases*	*Where disease is known*
1. Manganese	Sorrel, Buckwheat, Beet, Mangold, Lucerne, Clovers, Peas, Beans, Potato, Tomato, Carrot, Turnip, some Grasses, Yeast, Chlorella, etc.	(i) Oxidation-reduction regulator. (ii) Probably acts by oxidising Ferric to Ferrous Iron.	Chlorotic patches on leaves; in monocots, e.g., grasses, "streaks" or "stripes." Reduction or cessation of growth.	
			Grey Speck—Oats.	Europe, Britain, America, Australia.
			Pahala Blight—Sugar Cane.	Hawaii.
			Speckled Yellows—Sugar Beet.	Widespread.
			Marsh Spot—Peas.	Holland, England (Romney Marsh).
			Frenching—Tung Trees.	Florida, etc.
2. Zinc	Buckwheat, Broadbeans, Tomato, Barley, Fruit Trees, Duckweed, Aspergillus Niger, etc..	(i) Oxidation-reduction regulator. (ii) May ensure auxin content of plant. (iii) May catalyse carbohydrate transformations.	Intervenal chlorosis, mottled leaf, abnormal growth (rosettes), affects fruit trees mainly, also maize and some herbaceous plants.	*Note.*—No deficiency disease reported as occurring in Great Britain.
			Rosette—Pecan.	America.
			Little Leaf — Deciduous and Fruit Trees.	California.
			Mottle Leaf—Citrus.	California.
			Bronzing—Tung Trees.	Florida.
			Rosette—Pinus Radiata.	W. Australia.
			White Bud—Maize.	America.
3. Boron	Turnips, Swedes, Cabbage, Clover, Beet, Wheat, Beans, Peas, Carrot, Potato, Chlorella, Azotobacter, etc.	(i) Possible part in metabolism of carbohydrate and fat in plant. (ii) May have role in protecting flax against rust. (iii) May assist in regulation of plant absorbtion of anions and cations.	Early symptoms show death of the apical growing point, slight chlorosis, breakdown of soft meristematic tissue.	
			Heart Rot—Sugar Beet, Mangold.	Britain, Europe, America.
			Canker, Internal Black Spot—Red Beet.	Britain, America.

TABLE III—*continued*

Element	*Believed to be essential for at least the following plants:**	*Possible Biological Function in Plant*	*Deficiency Signs, Symptoms and Diseases*	*Where disease is known*
			Brown Heart (Raan)—Swede, Turnip.	Britain, Europe, Canada, America, Ireland, etc.
			Browning—Cauliflower.	Britain, etc.
			Crack Leaf—Celery.	Britain, etc.
			Top Sickness—Tobacco.	Sumatra.
			Yellow Top—Lucerne.	Britain, etc.
			Internal Cork—Apples.	Europe, Canada, America, N. Zealand, Australia.
			Brown Spotting—Apricots.	New Zealand.
4. Copper	Cabbage, Flax, Lucerne, Peas, Beans, Carrots, Potato, Wheat, Barley, Grasses, Aspergillus, Rhizopus.	(i) Forms part of many oxidising enzymes, e.g., polyphenol oxidase. (See Table IV, serial 1.)	Two general diseases known: (i) Reclamation Disease. Affects cereals. oats, beets, legumes, etc. On reclaimed heaths and moorland soils.	Denmark, Holland, Sweden, W. Australia.
			(ii) Dieback or Chlorosis. Affects fruit trees mainly. Fruit small, dry, shrunken. Multiple bud formation.	Florida, California, W. Australia.
5. Silicon	Beet, Maize, Barley, etc.	Function unknown.	No record of a natural deficiency.	—
6. Aluminium	Peas, Maize, Meadow Grasses, etc.	Function unknown.	Ditto	—
7. Chlorine	Garden Peas, Maize, Buckwheat.	Function unknown.	Ditto	—
8. Columbium	Penicillium Javanicum.	Function unknown.	Ditto	—
9. Tungsten	Penicillium Javanicum.	Function unknown.	Ditto	—
10. Gallium	Aspergillus Niger.	Function unknown.	Ditto	—
11. Molybdenum†	Tomato, Oats, Duckweed, Aspergillus Niger, etc.	Function unknown.	Experimental evidence only. In tomato mottling on lower leaves, abscission of leaves, no fruit.	—

Notes: * The lists of plants are incomplete. Only those which have a more direct and obvious bearing in their relations with animal life and nutrition are selected. In every case the essential nature has been amply demonstrated by direct experiment.

† See also paragraph on Toxic Elements.

different tissues of one animal, yet the ash content of the same species, and even different species, remains fairly constant (3-5 per cent.). A little consideration will show that in plants there is bound to be great variation, often merely on account of the nature of the plant (i.e., saprophytes, xerophytes, hydrophytes, etc.), and it has been shown that a plant can demonstrate much greater limits of tolerance as regards a particular element than an animal, this depending on the relative availability of the element in the environment. Table II gives some examples of this variation in the iron, copper, iodine contents of three common foodstuffs, and even in one type (potato).

Trace Elements in Plants

At the outset it will be as well to introduce an alternative term to trace elements—micro-nutrients. This term is in common usage as regards "traces" in plants, and is probably a more accurate description of its function. Set out on Table III there is a summary of the main micro-nutrients of plants, their possible biological functions, and the diseases that their deficiency from the soil may cause. There is a very formidable list of diseases affecting many plants of economic value, and in particular attention is drawn to the elements, manganese, boron and copper, deficiencies of which cause a whole variety of pathological conditions ranging from Grey Speck in oats to Reclamation Disease. Great Britain has its full share of deficiencies, but lack of zinc does not appear to be one of them. At first sight it may be thought that the diseases which result from simple deficiencies may be cured and prevented by mere addition of the particular element to the soil. This, however, is not always the case, and there is evidence to show that there is considerable relationship between the elements, e.g., should the manganese content of the environment be too low, iron in the soil, absorbed in the ferric state, will be reduced by the powerful plant reductase enzymes to the ferrous state, which will then induce a pathological chlorosis. In some experiments conducted by Shive it was found that there was a very definite optimum ratio, Fe/Mn (soya beans grown in water cultures), and that with a ratio of more than 2.5 and less than 1.5, i.e., manganese deficiency and iron deficiency respectively, there were definite and distinctly different pathological symptoms. Considerable work has been done on the relationship of one element to another, and besides the relatively close link between Fe and Mn it has been found that calcium (a principle element) can diminish the absorbtion and subsequent utilisation of manganese.

Copper forms a useful link between plant and animal, for it is essential for the life and health of both kingdoms. Moreover, we have here an excellent example of a micro-nutrient which may prove toxic. Copper sulphate is a well-known agent in combating algæ and fungæ, and concentrations of 1 in 10^8 can severely injure Spirogyra, and 1 in 800,000 prevent growth in wheat sprouts, whereas many plants have relatively high concentrations of Cu, e.g., potatoes 0.1 mgm./100 gm., hay 0.6-1.2 mgm./100 gm. This is a further illustration of the power of the living organism, this time plant, to absorb very small quantities of an element from the environment and then store it.

Many plant mineral deficiency diseases can be cured by application of the appropriate mineral to the soil, provided, of course, that excess, and therefore harmful, quantities are not added. For instance, heart rot in sugar beet (boron deficiency) can be prevented by the application of 4-13 lb. borax per acre.

TABLE IV

Trace elements of known or doubtful importance in animal nutrition.

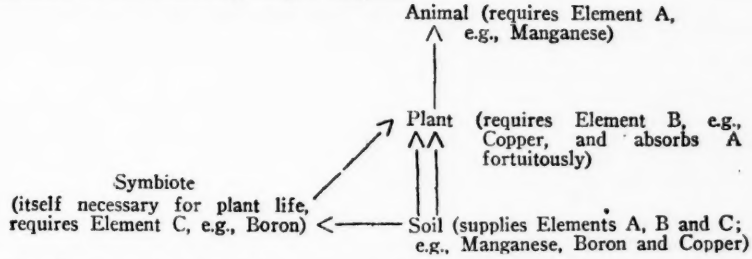
Element	*Biological properties and significance*	*Deficiency signs, symptoms and diseases*	*Where disease is known*
1. Copper	(i) Essential Element. (ii) Essential for proper utilisation of Iron in formation of hæmoglobin. (iii) Possibly essential in most if not all cells as catalyst of oxidations and reductions, e.g., Polyphenoloxidase, tyrosinase, and laccase are copper-protein complexes. (iv) Occurs as copper-protein compounds in red cells of some mammals (hæmocuprein), in liver also (hepatocuprein). (v) Also occurs as a respiratory pigment in the blood of certain invertebrates —Crustacea and Arachnida.	(i) Licking Sickness (Lecksucht). In cattle. Loss of appetite, anæmia, general degeneration, usually occurs concurrently with reclamation disease of plants. A similar disease affecting goats and cattle described by Sjollema may be due to copper deficiency. (ii) Salt Sick. In cattle. Very similar to Lecksucht, apparently due to copper and iron deficiency. (iii) Swayback (Swingback, Swingle-back). In lambs. Also known as Enzootic Ataxia. Lambs at birth have difficulty in standing and in taking their milk. General inco-ordination of movement, staggering, collapse, sometimes blindness. (iv) Salt sick and allied diseases may be identical with a series of diseases commonly attributed to Cobalt deficiency.	Holland. Florida. Widespread in U.K., especially in N. Derbyshire, parts Yorkshire, Mendips, Cheviots, Australia, India, Peru.
2. Cobalt	(i) Essential Element. (ii) Possible catalyst to liver enzyme arginase. (iii) Possible catalyst in oxidation of cytochrome c. (iv) Together with Iron and Copper can produce a true polycythæmia including an increase in blood volume.	(i) A series of widespread diseases in sheep and cattle, progressive debility followed by emaciation and anæmia. Coat becomes rough and staring. Known by following names :— (a) Pining, vinquish, daising (Cattle). (b) Pining (Sheep). (c) Mortains Mains Disease (Sheep). (d) Bush Sickness (Sheep). (e) Enzootic Marasmus (Sheep). (f) Nakuruitis (Cattle).	Scotland. Northumberland, Cumberland, Dartmoor and Exmoor. New Zealand (N. Island). New Zealand (S. Island). Australia. Kenya.

TABLE IV—*continued*

Element	*Biological properties and significance*	*Deficiency signs, symptoms and diseases*	*Where disease is known*
3. Iodine	(i) Essential Element. (ii) Essential for the formation of hormone Thyroxine.	(i) Endemic Goitre, Myxœdema, Swollen Thyroid and Neck, sluggishness, lowered basal metabolic rate, etc. Cretinism. More common to man, but known in cattle.	Human cases world-wide. In California and Mid-Western States (Cattle).
4. Fluorine	(i) Doubtful whether an essential element. (ii) Cannot replace Chlorine. (iii) Found in teeth enamel, bone, etc. (iv) Excess causes mottled teeth with imperfect calcification, and possibly interference with general cellular metabolism.	Experimental animals (rats) fed on diets containing very little Fluorine apparently maintain life and growth, and produce normal teeth.	As yet not known or reported.
5. Bromine	(i) Unknown whether essential. (ii) Cannot replace Chlorine. (iii) Suggestion that an organo-bromine compound has some relation to mental activity and sleep in particular seems highly questionable.	No satisfactory Bromine-free diet has been produced, and there are no known obvious signs and symptoms as a result of any possible deficiency.	Ditto
6. Nickel	(i) Unknown whether essential. (ii) Possible that it can replace Cobalt, at least to a limited extent.	None definitely established.	Ditto
7. Manganese	(i) Possibly essential. (ii) Seems to act as a cellular catalyst. (iii) Possibly essential for proper functioning and utilisation of Vitamin B_1.	(i) Perosis in chicks. A shortening and thickening of the leg bones, etc. (ii) Deficiency (e.g., in pigs) gives rise to symptoms similar to those which are obtained with low Vitamin B_1. Also progressive loss of fertility.	Possibly America.
8. Zinc	(i) Possibly essential. (ii) Occurs in combination with Insulin. (iii) Occurs in enzyme Carbonic Anhydrase, and apparently essential for its activity. (iv) Possible factor in Beri-beri syndrome.	As yet not known or reported.	As yet not known or reported.
9. Arsenic	(i) Unknown whether essential. (ii) Can prevent Selenium poisoning.	Ditto	Ditto
10. Aluminium	(i) Unknown whether essential.	Ditto	Ditto
11. Silicon	(i) Unknown whether essential. (ii) Fairly widespread in animal tissues	Ditto	Ditto

Not only the higher plants require trace elements but the lower ones also, and where possible examples have been given in Table III, including Yeast, Aspergillus, Penicillium Javanicum, etc. This, then, is a further link in the biological inter-relationships and has, too, another application in that many of these fungi have a direct value to medical and veterinary therapy (penicillin).

We can summarise this relationship between plants and animals "trace" metabolism in the following simple diagram :—


Animal (requires Element A, e.g., Manganese)
Plant (requires Element B, e.g., Copper, and absorbs A fortuitously)
Symbiote (itself necessary for plant life, requires Element C, e.g., Boron)
Soil (supplies Elements A, B and C; e.g., Manganese, Boron and Copper)

In this example the soil is represented as supplying to the plant, amongst all its elements, three of special significance, A, B and C. A is required by the animal, and as long as it is in the soil it will be absorbed by the plant; B is required by the plant, and so long as B is in the soil the plant will be healthy and will be able to absorb A and supply it to the animal. Finally, Element C is supplied to some symbiote, as, for example, *Bacillus Radicola,* which forms the nodules on vetch roots and the proceeds to fix nitrogen, which in turn will go to make a healthy soil for other plants, and, as a point of direct interest, boron appears to have this very important property of "encouraging" the activities of this and other bacteria.

Trace Elements (including Toxics) in Animal Nutrition

We return to the term "trace" element at this stage, and the reader is referred to Table IV, which lists the more important "traces" of animal importance, together with their possible biological functions and deficiency diseases. Attention is drawn in particular to copper, iodine, cobalt, manganese and zinc; all these have some definite and even economic importance, but the remainder, although they are fairly widely distributed, are of very doubtful value and their functions in the animal body are not understood. Two elements of considerable interest are not included in this list; they are selenium and molybdenum. Both these are toxic elements and are responsible for well-defined diseases in certain areas of the world. Many years ago a disease affecting all domestic animals and poultry was noted in the plains of mid-Western States of America; this was known as Alkali Disease, since it was considered that it was induced by excessive alkali in the diet. But very careful work by Larsen *et al.* in 1913 established that this was not the cause and 20 years later Byers suggested that selenium might be the responsible agent. Many workers have since verified this, and several interesting facts and figures have been produced. The minimum lethal dose for rats, rabbits, horses and mules is of the order of 1.5-2 mgm./kilo body wt., for cattle 4.5-5, and for pigs 6-8. However, lesser doses will cause the disease, and concentrations of 5-10 p.p.m. can bring on the symptoms, which include loss of hair from mane and tail of horse, loss of hair from tail of cattle and body of pigs, wasting of hooves often resulting in their being completely sloughed off, and a prevention of hatching in chicken's

eggs. A very close survey has been made of the absorptive power of plants for selenium, and as a result plants have been divided into three categories, according to whether they absorb large, moderate or small quantities of this element. Treatment of the soil with sulphur (a close chemical relative) or gypsum depresses the power of plant to assimilate selenium. It is also interesting to speculate whether selenium is, in fact, preventing the formation and maintenance of the scleroproteins of the animal's hair, horn, etc.—which normally contain relatively large amounts of the sulphur containing amino-acid cystine—by preventing the utilisation of sulphur. Also arsenic has been shown to have a definite protective value in cases of selenium intoxication.

From America we return to Britain and find that on certain so-called teart pastures—particularly in Somerset, Warwick, and to a lesser extent Gloucester—derived from the Lower Lias, there is a disease affecting cattle, and to a certain extent sheep, known as scouring. This involves a general loss of condition, the production of loose, watery dung with a foul smell, staring of the coat (cattle), and diminution of the milk yield. The work of Ferguson, Lewis *et al.*, and Muir has resulted in the discovery that this condition is due, primarily, to relatively high percentage of molybdenum in the soil and herbage. There is some seasonal variation in the molybdenum content of the herbage, the scouring tendency being greatest in the spring and September and less at other times. Copper has proved a beneficial antidote in the prevention of scouring when administered to young cattle, and the use of acidic fertilisers containing ammonium sulphate valuable in curtailing the plant's uptake of molybdenum. This may be due to the fact that the excess of fertiliser increases the yield of grasses without necessarily increasing the quantity of molybdenum taken up.

In dealing with molybdenum and selenium, we have two more or less well-defined specific diseases, but is the veterinary practitioner likely to come across any other positively toxic diseases? The answer is: Yes. A good example is that of fluorine. Numerous world-wide cases have been reported of fluorine poisoning. This appears to be due to two main causes. Firstly, the assimilation of abnormally large amounts of fluorine from food, drinking water or phosphatic licks (these are often rock salt which contain about 4 per cent. fluoroapatite), or from contaminated herbage near factories where hydrofluoric acid, silicon fluoride, or even fluoride dust may be emitted (Superphosphate, Glazed Brick, Aluminium, etc., etc.). The symptoms are primarily a severe mottling, weakening, and often decay of the teeth followed by a general drop in condition. Large doses may even prove lethal. It is, of course, possible to obviate, or even avoid, some of these causes, as, for example, in the case of phosphatic licks, which should, if possible, be selected for their quality. Not all rock phosphate is heavily contaminated with fluoride, and there are certain high-grade phosphatic rocks from Curaçao and the Christmas Islands, for example, where the fluoride content is very low.

Conclusion

The specialist may wish to over-emphasise his subject at the expense of others which he feels are of lesser importance, but it must be borne in mind that to place varying and arbitrary degrees of emphasis on the many aspects of biological activity is quite valueless and will do more harm than good. For, although there is no reason to doubt the scientific significance and economic value of the "trace"

elements or micro-nutrients, there is every reason to view them in their right perspective. After all, they are merely members of a large family of 96, and we must not allow the (trace) tail to wag the (mineral) dog! Both groups require each other and both are equally important in the realms of pure and applied science.

NOTES AND NEWS

FEEDING OUR FLOCKS AND HERDS†

SUPPLIES of imported feeding stuffs next winter will still be very short. Hence, if farmers are to feed their stock adequately, they will again have to rely for the most part on their own resources. Some will be able to attain self-sufficiency; others may even achieve a surplus and so be able, of their abundance, to help people less favourably situated or less well provided with the requisite equipment. There is urgent need of more livestock of all kinds, but especially those that can be sustained mainly on home-grown fodder and foodstuffs.

Before the war rather more than eight million tons of feeding stuffs in the form of cereals and oil seed products were imported and these provided from 20 to 25 per cent. of the total nutrients consumed by farm animals. When one reflects that one acre is needed to produce one ton of foodstuffs in the form of cereals, it seems remarkable indeed that the numbers of our animals have been so well maintained. Under permanent grass (hay or grazing), the total production of equivalent food units is only about two-thirds as much as from tillage. On the other hand, roots or green crops such as kale produce twice as much food value as cereals, and three times as much as permanent grass. So it is obvious that the change-over to arable farming, the introduction of leys and the more intensive farming of the grassland that remained have been important contributing factors in the direction of maintaining and sustaining our herds. By going all out, intensifying the cropping, modifying methods of stock-feeding, avoiding waste and making use of sources of food supplies hitherto untapped, we have been able to provide the necessary sustenance for man and beast in a manner and to an extent that seemed impossible to people who based their calculations on pre-war farming practice and pre-war dietaries.

But there is still great scope for improving the output of grassland. Indeed, if the yield of food nutrients obtained up to the present from grass were raised 40-50 per cent., the additional supply properly conserved would go far to meet the full nutritional requirements of our animals. This would mean at most increasing the yield of hay from 20 to 30 cwt., and of grass silage from 3 to 4½ tons per acre—not an impossibility, granted fertilisers in sufficient quantities.

We need to aim at full stocking of our grassland in summer and getting it to contribute far more than in the past to winter food requirements. Silage is one way; better quality hay and—where necessary—renewal of grass by re-seeding are other ways.

More use should be made of straw for feeding purposes and we should take greater care of it. Roots or kale and straw together have still the feeding value that formerly enabled farmers to carry many animals through the winter with little

† Ministry of Agriculture and Fisheries, June 17, 1947.

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or no concentrates. No arable land that can bear useful herbage should repose in idleness through the autumn and winter.

Poultry and pigs are inevitably hard hit. We should aim at wider distribution and more individual flocks and herds, even if quite small. In some circumstances we might do worse than return to the pig-keeping methods of the 70's and 80's of last century, breeding from gilts taking only a summer litter and fattening off gilt and litter on the waste products of the autumn harvests.

With sheep, on the other hand, circumstances demand that ewes should be bred from longer, and all suitable ewe lambs retained for breeding purposes.

THE INFLUENCE OF WIND ON PESTS*

THE influence of wind on the distribution of small insects, particularly agricultural pests, and the extent to which this country is being infected by such insects from the Continent, is being investigated by Professor A. C. Hardy, Linacre Professor of Zoology and Comparative Anatomy at Oxford University. He began the experiments before the war when he was at University College, Hull, studying the height to which insects may be carried, by using nets on kites up to 2,000 feet, and also to find out how far they may be carried by flying nets on ships crossing the North Sea. The nets were only flown from the mast-head, when the ships were more than 100 miles from the nearest land; so it was known that all insects so caught had travelled at least 100 miles and could easily be carried into this country across the Channel.

Professor Hardy is now resuming this research and, with the assistance of the Royal Air Force, is sampling the air actually coming into England over the South Coast on days when the wind is in a suitable direction. He must use a large net and a machine that will fly at a slow speed. The Helicopter is ideal and is being used for this. When conditions are suitable, the machine makes a patrol flight off the South Coast in the region of Beachy Head, towing a conical net with an opening of 50 square feet. The Professor is particularly concerned to find out to what extent this country is being invaded by the Bean Aphis, the small black fly that causes such extensive damage to bean crops.

* Ministry of Agriculture and Fisheries Weekly News Service, No. 403, 1947.

GOOSE REVIVAL†

In former days goose breeding in this country was widely practised; flocks of several hundreds were not uncommon on farms, and cottagers often grazed small flocks on common lands and roadsides. Then more recently the demand for goose flesh fell away until the introduction of meat rationing. Now it has again revived because meat of all kinds is scarce.

Geese are much easier to keep than other classes of poultry; they will thrive in very simple houses or even without cover, and they can be maintained solely on grass during most of the year. The aptitude of geese to make use of grass has in recent years greatly increased the interest in goose production, and there is now a good market for goose eggs and goslings at all ages. But there is

† Ministry of Agriculture and Fisheries' *Weekly News Service*, No. 403, 1947.

much room for further development, for a few geese can usually be maintained very easily on odd bits of waste land. One acre of grass will provide food for 8-12 geese or 20-30 goslings.

Nowadays there is little demand for a very large goose—we prefer a small compact carcase. The Roman and White Chinese geese are very well suited to present-day market requirements. Both breeds are very hardy; they are good layers and carry good quality flesh. The colour is another advantage, for white goose feathers are particularly valuable.

Breeding geese is much less troublesome than breeding fowls, because the same birds mated together will usually give good results for about ten years. But ganders are not normally very fertile in their first season, so it is advisable not to use them until they are two years old. Some birds are shy and do not settle down quickly with the gander, so they should be mated at least 4-6 weeks before saving eggs. Throughout the breeding season, breeding stock should be kept in good store condition and should require little food except what they pick up by foraging. When the grass is somewhat scarce in the early part of the year, one feed of 2 oz. of mixed grain daily should be given.

Goose eggs are more difficult than hen eggs to hatch in incubators, so they are usually hatched under geese or hens. With a good demand for hatching eggs or goslings, it is better to maintain production by breaking broodiness in the geese and to set the eggs under hens. Farmers using incubators often transfer the eggs to hens for the last week before hatching.

Brooding and rearing are simple. The goslings require comparatively little heat and are not subject to many of the ordinary poultry diseases. Brooding may be done either by natural or artificial methods. During the first few days the goslings should be given restricted range; but after one week they can be allowed free range, except in bad weather. During the first two weeks they should be fed four times daily. Chicken foods are satisfactory, but mash must be fed moist. From 2-4 weeks the food should be reduced, so that at one month old the birds have to forage for their own food.

The grazing of geese promotes an excellent sward. Contrary to common belief, their droppings do not make grass obnoxious to other grazing animals. As young grass is much more palatable than old, geese do best when kept on grass not more than three inches long.

In a normal year it should not be necessary to give goslings any supplementary food until the end of August; but an extra feed of meal once daily is desirable, if the herbage gets badly burnt up during a hot spell. From August onward grass loses much of its nutritive value and goslings make little progress unless given some supplementary food. No additional cereals are required for a very considerable period if the goslings are allowed to graze over stubble. Where grass is poor and stubble land not available, it may pay to sell off the goslings. Nowadays there is a ready market for stock at all stages of maturity.

Birds to be sold for table should be given more liberal feeding during the last month. Before rationing came in, cereals were largely used for fattening; but now it is customary to depend largely on cooked chat potatoes and other surplus vegetables.

YOUNG LAMBS ON GRASS*

Two factors, above all others, favour the rapid growth of young lambs on grass. One is a heavily milking mother, the other is fresh succulent pasture on which to graze. Particularly during the first month of life a lamb's rate of growth is in almost direct proportion to the quantity of milk it drinks. This is clearly shown by the fact that in the first month the rate of growth of single lambs is almost double that of twins in the same flock. As the lamb grows older and starts to graze in earnest, the quality of the pasture becomes increasingly important. The lamb drinks less milk as the ewe's lactation declines; it eats more grass as its own appetite increases.

Now quality of grass is of greater importance to lambs than quantity. Pasture in which cattle wade knee-deep is next to useless for them. On over-shot, stemmy grass they will not thrive. Unless pasture is young, green, short and succulent, lambs soon lose their bloom and baby flesh. These qualities of a pasture are of far greater practical importance than its botanical composition. Rye grass, cocksfoot and clover at their proper stage of growths are all excellent feeds for sheep. But if through drought, under-stocking or ill-management they should become fibrous, brown and stemmy, then they are not fit food for lambs. In fact, in drought, lambs may thrive better when grazing wild herbs in the sun-shaded shelter of hedge-side and lane than they will do on any cultivated and unshaded pasture. Briefly, considered as lambs' food, the youth of a crop is of far greater moment than the seeds mixture from which it has been grown.

These two factors, then, ewes' milk and fresh pasture, are what make lambs grow. There are other factors that oppose that growth. Probably the most important of these is sheeps' worms, the small stomach worms being those of most significance. All grazing sheep contain worms, and lambs are much more easily damaged by worms than are older sheep. It takes a lot of worms—an infestation of several thousands—to kill a lamb, but much smaller numbers are enough to hinder its full growth. The drug phenothiazine, sold nowadays by all the big chemical firms in one form or another, is undoubtedly much better than any other remedy previously available. Its routine use is a sound precaution. But sometimes—indeed, quite often—worms are blamed and worm remedies applied when lambs are suffering from lack of milk or a drought-stricken pasture. Worm medicines are most useful things, but obviously no remedy for thirst or hunger.

* Ministry of Agriculture and Fisheries, June 17, 1947.

FOOT-AND MOUTH DISEASE RESEARCH COMMITTEE†

THE Minister of Agriculture and Fisheries has reconstituted the Foot-and-Mouth Disease Research Committee with the following membership:—

Dr. A. N. Drury, C.B.E., M.D., F.R.S. (chairman).
Dr. C. H. Andrews, M.D., F.R.C.P., F.R.S.
Professor S. P. Bedson, M.D., D.Sc., F.R.C.P., F.R.S.
Sir Daniel Cabot, M.R.C.V.S.
Mr. T. Dalling, M.A., M.R.C.V.S.

† Ministry of Agriculture and Fisheries, July 24, 1947.

Dr. R. E. Glover, F.R.C.V.S.
Dr. Russell Greig, Ph.D., M.R.C.V.S., F.R.S.E.

Dr. I. A. Galloway, Director of the Foot-and-Mouth Disease Research Station, and Mr. F. A. Eveleigh, of the Ministry of Agriculture, have been appointed secretaries to the committee.

The terms of reference of the Committee remain as follows:—

"To initiate, direct, and conduct investigations into foot-and-mouth disease either in this country or elsewhere, with a view to discovering means of rendering the invasions of the disease less harmful to agriculture."

EXPORTS OF LIVESTOCK FROM GREAT BRITAIN TO NEW ZEALAND

THE New Zealand Government has removed the long-standing embargo on direct importation of animals from Great Britain. This action brings New Zealand into line with all other Empire countries so far as direct importations from Great Britain are concerned, and it means that animals need no longer be taken to Canada or Australia and detained there for a period before completing their journey to New Zealand. Subject to certain safeguards against the introduction of animal diseases, the New Zealand Government will issue permits for the importation of cattle, sheep, goats and swine from this country.

The new Regulations require that animals shall have been domiciled in Great Britain for at least three months or, in the case of young stock, from birth; and that for 14 days before they are shipped they shall have been kept in a quarantine station under the control of the Ministry of Agriculture and Fisheries. Health examinations and the testing of the animals for brucellosis are required to be carried out by approved vterinary surgeons within 30 days before they are removed to the quarantine station. In the case of cattle, tests for tuberculosis and Johne's disease are also required.

On arrival in New Zealand the animals will be subjected to a further veterinary examination and will be required to undergo a period of 30 days' quarantine. As the Quarantine Station at Auckland is not yet available, it is necessary for the present for all stock to be landed at Wellington.

Details of the New Zealand regulations and of the conditions of entry of animals into the Quarantine Stations at London, Liverpool and Glasgow, may be obtained from the Ministry's Offices at 99, Gresham Street, London, E.C.2.

OPEN LETTER TO THE ROYAL COLLEGE OF VETERINARY SURGEONS

THIS is an appeal from a human nurse (and soi-disant canine nurse) to the veterinary authorities in this country to lead the world in setting a professional standard for canine nurses.

At present, as is well known, anyone—whether she has ever handled a sick dog in her life or not—can call herself a canine nurse; and even though she has had a considerable nursing experience, her methods may be, and very often are, entirely out of date, unscientific, and even unhygienic. There is no remedy, and people are obliged to employ such nurses for lack of anything else.

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This has two glaring disadvantages. One is obvious—the trouble caused to the patients, the veterinary surgeon, and the owners.

The second is less obvious—the danger to the dog world when these ignorant and untrained kennelmaids or kennelmen pose as experts and do all sorts of treatments for poor people, who are influenced by their sympathetic manners and assumption of great experience. How often have I heard the remark: "I'd rather have Miss So-and-so than any vet."!

In the big kennelmaids' training schools we teach the students the sharp line between their proper sphere and that of the veterinary surgeon, and it is instilled into them that they are not to be little quacks. Unfortunately there are more untrained than trained kennelmaids.

A person like myself, with a real vocation for canine nursing, may work for years under veterinary surgeons, and in the (pre-war) recognised distemper homes, but at the end we have no professional status.

As this would be an interesting and much-needed new career for women, and as the creation of the Veterinary Educational Trust and the keen interest in the development of veterinary research is focussing interest on this subject and adding to the demand for properly trained women, this seems a suitable moment to deal with the matter.

Would it not be possible to accept nursing students at the Veterinary Colleges, or, failing that, at recognised veterinary establishments where surgical, medical and maternity courses could be taken?

The matter really is urgent. The horrors of human "nursing" in Florence Nightingale's day are certainly no worse than much "canine nursing" that goes on to-day.

We cannot, I suppose, expect to win our case at once, considering the opposition to the training of nurses in the old days, but I do most urgently and earnestly appeal for the consideration and ventilation of this subject—which I personally know is warmly supported by many modern veterinary surgeons.

I remain,
Yours truly,
NADYNE JOERGENS (Miss).

Bellmead Kennels,
Haslemere, Surrey.

CORRESPONDENCE

The Editor, THE VETERINARY JOURNAL.

DEAR SIR,—Thanks for the encouragement of your editorial entitled "The Clinician is Important" in the May, 1947, number of your journal. If we accept as true the dictum of Bernard Shaw that "all thinking is wishful thinking," most practitioners—of whom I am the least—will, in any case, agree with your conclusions.

But, at that, we may be right and I, for one, find reason enough in your arguments and in my own experience to be quite sure that you and we are right.

There are times and occasions in veterinary service, such as active military operations, raging epizootics, and the sea-transport of animals, when the clinician, as such, is temporarily out of the picture, and the official is the man of the moment But, even then, it is true, as a rule, that a sound clinical background is a basic necessity for the most intelligent direction of an animal-disease problem.

For if a veterinarian has not that background it may well be asked what background he can have as well suited to make him the sort of natural philosopher and practical man of affairs a proper veterinarian must be.

My experience has been that without such a background veterinary direction is apt to lack common or horse sense in an emergency. Your leading article, as well as being wise, is also opportune. The socialisation of veterinary as of human medicine is threatening to give the official too much power and to subordinate the clinician to the bureaucrat to a discouraging degree.

Veterinarians in the main must deal with farmers, and it has been found that the best way for one to win a farmer's confidence is to take a load off his mind by some prompt and effective clinical action.

After that the farmer will take advice, and thus the way is cleared for the official control of disease.

So true is this that it is possible to estimate the value of the clinical service a farmer has had in the past by his readiness to co-operate in veterinary plans for the future. And without the real and willing co-operation of the farmer so-called disease-control in a free country is a farce.

Here is just one instance in support of your conclusions, and almost every experienced practitioner could think of others.

Yours faithfully,
J. W. RAINEY.

Deloraine, Tasmania.
June 28, 1947.

REVIEWS

Studies on Pathological Conditions in the Testis, Epididymis and Accessory Sex Glands in the Bull. By E. BLOM and N. O. CHRISTENSEN.

THE authors commence by rendering a complete anatomical survey of the bull's genitalia, excluding the penis. There may be found both original observations and observations not usually stressed in current literature. A "recessus urogenitalis" is described. This structure, hitherto unnamed, takes the form of a small urethral diverticulum at approximately the level of the ischial arch. Associated with the mucosal fold demarcating the diverticulum from the urethra are the openings of Cowper's glands (bulbo-urethral). Note is also made of the uterus masculinus, which is stated to be of more common occurrence in the bull than generally realised. Two forms of the uterus masculinus, not previously described in the bull, are defined.

Following this anatomical discussion, clinical examination of the bull is dealt with. Attention is paid to the examination of the animal's general condition as an indication of localised affections of the genitalia. Marked atten-

tion is paid to examination of the seminal vesicles. In this connection variations in relationship with the ampullæ vasa deferentia are recorded.

The author's bromythymolblue-catalase test for the hydrogen ion concentration of the semen, and its catalase activity, is given in detail. Among the *post-mortem* findings an interesting anomaly termed "Segmental aplasia of the Wolffian duct" was noted. In this condition, which is probably hereditary, part or whole of the epididymis may be absent. It is recorded in the Red Danish Milk Breed and Jutlandic cattle. An apparently normal animal with this condition may have a functionless testicle throughout life. Only a very thorough clinical examination of the adult bull will disclose the condition.

It is probable that this paper will be of particular interest to British veterinary surgeons examining bulls for certificate purposes. Unfortunately from our point of view in this country, the work done has been solely on cattle free from tuberculosis. Consequently the pathology of this disease in the genitalia is not compared with that of other infections.

Developmental anomalies and acquired lesions, including Brucella abortus, Corynebacterium pyogenes and Streptococci infection, are dealt with as they occurred in the material available. Apart from a few grammatical errors in translation, the report is a faithful one and the data well authenticated.

H.D.M.

Veterinary Anæsthesia. By J. G. WRIGHT.
London, Baillière, Tindall and Cox, 1947. Price: 12s. 6d.

THE second edition of this book, presented in January of this year, does much to enhance the value of a text-book which still remains unique in veterinary literature. Problems of veterinary anæsthesia being, at present, to the fore, it is an opportune moment for this new edition. Reference to this book would certainly provide a basis for any new legislation contemplated in the realm of anæsthesia for domestic animals.

In the main, the book remains unaltered, but there are additions. Information is now given on the subject of ether anæsthetisation by intratracheal intubation of the dog. Cyclopropane anæsthesia in the dog and cat also receives attention in this edition. Both chloral hydrate narcosis in horses and cattle, and bovine paravertebral anæsthesia are more fully discussed. Finally, there is now a chapter included which treats with anæsthetisation of small laboratory animals. This will be of especial interest to laboratory workers.

H.D.M.

Diagnostic Methods in Veterinary Medicine. By G. F. BODDIE, B.Sc.(Edin.), M.R.C.V.S. 2nd Edition. 328 pages. Edinburgh, Oliver & Boyd, Ltd. Price: 15s.

THE early appearance of a second edition of Professor Boddie's book indicates that the demand for this work has been considerable, and there can be no doubt that in a very short period of time it has come to be regarded as a standard work on diagnostic methods in veterinary practice.

Correct diagnosis is the basis of rational therapeutics and thus an understanding of the methods of investigating the causes of disease is essential to the clinician "Those who wish to succeed," says Aristotle, "must begin by asking the right question." Professor Boddie's book provides, in a readable and concise form, a guide both to the detailed clinical examination of the patient and to various easily performed laboratory procedures which may be employed to supplement and elucidate clinical findings.

On comparing the second with the earlier edition it is evident that the revision of the text has been carefully carried out, and that certain subjects are now dealt with in greater detail. One notes, for example, that more consideration is given to the bovine udder and that conditions affecting the locomotor system are discussed more fully. The new drawings made from radiographs illustrating various abnormalities of bone are well executed, but it cannot be said that they are satisfactory substitutes for the actual skiagraphs.

The section devoted to "Clinical Bacteriology" has been improved by detailed descriptions of the commoner staining methods and also of the technique for the detection of mastitis organisms in milk and the demonstration of Brucella abortus in vaginal discharges, etc., by microscopic methods. The procedures described can be readily carried out by a practitioner with a minimum of apparatus and facilities. The inclusion of a number of coloured plates illustrating important disease-producing organisms enhances the value of this section. One would suggest, however, that the Johne's fæces film shown in Fig. 34 would be more typical if it also demonstrated some of the non-pathogenic fæcal acid-fast organisms which, if not correctly identified, may lead to errors in diagnosis.

The scope of the second edition has been further extended by a new chapter on the "Diagnosis of Poultry Diseases," for which Mr. J. G. Campbell, F.R.C.V.S., is responsible. In addition to outlining the method of approach to the investigation of disease on the poultry farm, this chapter also includes an excellent description of the technique to be followed for *post-mortem* examination of poultry.

Dr. Holman's contribution on "Clinical Hæmatology" has also been revised, and although the inclusion of this chapter in the first edition was criticised by one reviewer on the grounds that the subject was too advanced for a work of this character, there has recently been evinced an increasing interest in the investigation of the blood picture in animals. It has been shown, for instance, that determination of the total and differential leucocyte count may be of considerable diagnostic and prognostic value in bovine reticulo-peritonitis and pericarditis. With the aid of Dr. Holman's lucid description, and a little patience, the technique of blood examination can readily be mastered. One ventures to suggest that, in the next edition, the inclusion of further coloured plates illustrating normal and abnormal blood cells would be an added advantage.

Considering the work as a whole, the full title, viz., "Diagnostic Methods in Veterinary Medicine," seems to the reviewer to be a better description than the abbreviated "Veterinary Diagnosis" which appears on the outer cover. Professor Boddie, without any doubt, expounds adequately the method of clinical examination in the field and describes the more readily performed laboratory tests, but if the potential reader expects to find every aspect of diagnosis covered, as the shorter

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title might lead him to expect, he will be disappointed that in many cases the findings which arise from the separate examination of the various bodily systems, etc., are not more closely integrated. In this respect the method adopted in considering the differential diagnosis of the various types of colic in the horse, where all the symptoms which may be displayed are discussed collectively, might with advantage be extended to other subjects.

As a guide to the technicalities of diagnostic procedure the first edition has already proved the book to be of great value to students, to practitioners and to all whose interests tend to the clinical side of veterinary medicine. Professor Boddie and his collaborators now deserve to be congratulated on the result of their efforts to extend the usefulness of this work in a second edition.

G. A. W.

A Centaur Looks Back. By LIEUT.-COL. V. C. LECKIE, D.S.O., R.A.V.C. Hodder & Stoughton, London.

IN these days of mechanisation it is good that a record should be made of the type of life led by those whose job was to look after our friends the army horses, mules and other animals.

Col. Leckie has an apt pen and his story, which is something of an autobiography, will be read with interest, not only by members of his own profession, but by all those who are interested in animal and bird life and sport.

In his journeys about the world Leckie proves that he kept his eyes open and many of his descriptions of the places which he visited and of the animal and plant life encountered would do justice to any professional naturalist.

To me it brings some sentimental regret for having had the chance to emulate Col. Leckie and stay in that great corps the R.A.V.C. I foolishly discarded my opportunities and so lost all that Col. Leckie has gained and so lucidly put on record. Young men who read the book will sigh for the life and days which are, by the curse of the internal combustion engine, no longer open to men with the spirit of adventure throbbing in their heart.

J. McC.

Publishers' Notices

Copy of advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 1st of the month, if proof is required.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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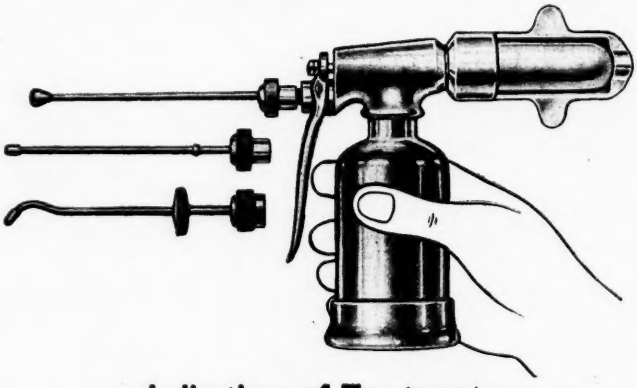

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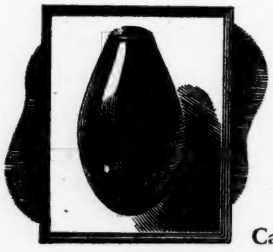

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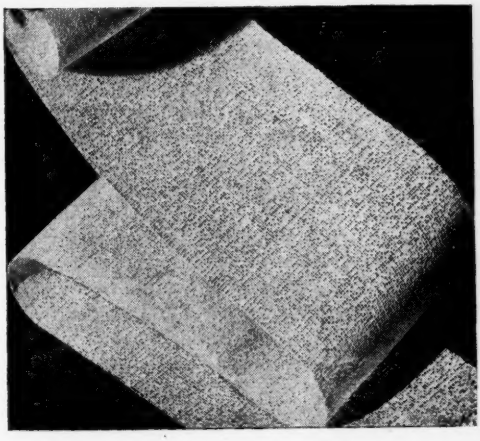

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